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XVIII. "On the Properties of Electro-deposited Antimony"
(concluded). By GEORGE GORE, Esq. Communicated by
Professor STOKES, Sec. R.S. Received May 24, 1862.

(Abstract.)

In this communication the author has described two additional kinds of electro-deposited antimony possessing the property of evolving heat; one of them is obtained from a solution of bromide, and the other from a solution of iodide of antimony; there is also given additional information respecting the peculiar heating-antimony obtained from the aqueous terchloride.

The following is a brief statement and comparison of some of the properties of the three kinds of thermically active antimony. The specific gravity of the chloride deposit is 5·8, the bromide one 5·44, and the one from the iodide 5·25. The amount of heat evolved is greatest with the one from the chloride solution, and least with that from the iodide; the former evolves all its heat at 60° Fahr., by contact with a red-hot wire, the bromide one at 280° Fahr., whilst the iodide one requires a temperature of 340° Fahr.; the latter also acquires a reddish-brown colour by exposure to solar light.

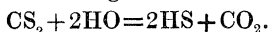
The chloride deposit contains about 6·3 per cent. of saline matter, the bromide one about 20, and the one from the iodide liquid about 22·2. The quantities deposited by a single equivalent of zinc were about 42·5 in the chloride, 50 in the bromide, and 51 in the iodide solution.

The explanation proposed of their formation is, that the antimony in depositing, being in the "nascent" state, combines chemically in a feeble manner with the saline ingredients of the electrolyte; but the complete sources of the evolved heat remain undecided.

XIX. "On the Sulphur-Compounds in Purified Coal-Gas, and on Crystallized Hydrosulphocarbonate of Lime." By the
Rev. W. R. BOWDITCH, B.A., F.C.S., Wakefield. Commu-
nicated by Professor WILLIAM THOMSON, M.A. Received
June 14, 1862.

The following facts relative to sulphur in what is called purified coal-gas, are additional to those already submitted to the Royal Society.

When I first made known the action of heated lime upon coal-gas, chemists accounted for the phenomena observed by two assumptions : —I. That the sulphur-compound decomposed was free bisulphide of carbon. II. That the decomposition was due to a reaction between water and bisulphide according to the following equation :



It was easy to show that these assumptions were erroneous, but exceedingly difficult to demonstrate the truth.

That the sulphur in gas does not usually exist as free bisulphide of carbon is proved thus.

Gas which has been purified at the gas-works by lime, and which contains 20 or 30 grains of sulphur in 100 cubic feet, may be passed for a considerable time through a tube containing cold slaked lime without producing discoloration ; but if the same gas be charged with a minute quantity of bisulphide-of-carbon vapour and passed through the same lime-tube, the lime becomes yellow and green from decomposition of the bisulphide of carbon.

If instead of passing the gas through lime it be passed through triethylphosphine, the beautiful red crystals which this base gives with bisulphide of carbon are not formed ; but if the base be dissolved in alcohol or ether, and the gas passed through this solution, the red crystals are formed, as Dr. Hofmann first proved. The alcohol or ether dissolves out the bisulphide of carbon from the hydrocarbon compounds of which it forms a part ; and when it is thus dissolved it reacts with triethylphosphine.

Naphthalin, benzole, and other fluid hydrocarbons condensed from purified gas yield sulphide of hydrogen and other sulphuretted compounds by simple distillation, yet these do not produce the well-known red crystals with triethylphosphine. They may, moreover, be digested for weeks in an alkaline solution of oxide of lead without producing any sulphide of lead. Under similar treatment bisulphide of carbon yields hydrosulphocarbonate and sulphide of lead in a few hours.

If the sulphuretted fluid hydrocarbons condensed from gas be mixed with ammoniacal alcohol and heated, and an alcoholic solution of acetate of lead be then added, a black precipitate is formed after some time, which evolves sulphide of hydrogen upon addition of an acid. In this case neither hydrosulphocarbonate nor hydro-

sulphocyanide of ammonia is formed ; yet it is well known that both are formed when bisulphide of carbon is added to ammoniacal alcohol. The erroneous view of the action of heated hydrate of lime upon the sulphur-compounds in gas arose, I think, from the generally received opinion that the blackening of lead-salts by a gas is a proof that that gas is sulphide of hydrogen—joined to the fact that sulphide of hydrogen is one of the compounds produced by the action of the heated lime. If the sulphide of hydrogen had been separated from the mixture of gaseous compounds produced, the truth would have been apparent ; but as, I believe, all experimenters have failed to separate them, the subject was obscure. After having failed in many processes devised by myself and suggested by others, I at last removed the sulphide of hydrogen, and showed that the blackening of lead-salts is no proof of the presence of sulphide of hydrogen. Ordinary purified gas was passed over heated hydrate of lime, then through a considerable quantity of well-washed hydrated peroxide of iron, over lead-paper, and subsequently through moist slaked lime. The peroxide of iron was slightly blackened, and withdrew every trace of sulphide of hydrogen : the lead-paper became black, and the slaked lime yellow. This yellow lime gave a primrose-coloured solution with water, which precipitated lead- and silver-salts brownish red, thus showing the presence of impure hydrosulphocarbonate of lime.

To be certain of the absence of sulphide of hydrogen, some of the yellow lime was treated with hydrochloric acid, and the gases evolved thereby were conducted into a solution of potash. The potash solution gave no reaction with nitroprusside of sodium, showing the absence of sulphide of hydrogen, and when boiled with nitric acid gave no precipitate with a salt of baryta.

The hydrochloric solution of the lime contained a sulphur-salt, which was obtained as sulphate of lime when nitric acid was added and the whole was boiled.

The blackening of the lead-paper in this case could not be due to sulphide of hydrogen, as that compound was absent. Nor I think is it due to the hydrosulphocarbonic acid which passed over, and in contact with, the lead-paper, and was arrested by the lime. The red compound which this acid produces with lead-salts is said to turn black rapidly ; and the red compound produced by a lead salt, and those of Berzelius and Zeise, undoubtedly does so blacken, as also

does that produced by a salt of lead and an alkaline pentasulphide. I have, however, obtained a red lead-salt by the reaction of crystallized hydrosulphocarbonate of lime and basic acetate of lead, which remains red after drying in the air at ordinary temperatures and exposure for weeks to the free atmosphere. I therefore conclude that the blackening of the lead-paper in the above case was not due to hydrosulphocarbonic acid, but to some unknown or unsuspected compound.

In order to understand this matter fully, I commenced some investigations into the reactions of bisulphide of carbon with metallic oxides and other compounds, a portion of which I have now the pleasure of submitting.

Red Crystallized Lime-Salt.—Slaked lime and bisulphide of carbon are mixed in a close vessel, and allowed to stand for three or four days. The lime at first becomes of a pale primrose-colour, which gradually deepens to a fine lemon-yellow. Water added to the yellow lime gives a solution of a gold-colour, which precipitates salts of lead and silver reddish brown, and salts of mercury brown. These precipitates become black upon standing a short time. If the yellow solution be allowed to remain for a few days in contact with the lime, crystals are formed which will be very small, and so distributed through the lime as merely to give it a fine salmon-colour.

This lime-salt is of a bright ruby colour, and by the following process it may be obtained in beautiful crystals. Freshly slaked lime is to be mixed with so much water that, when stirred, it will aggregate into small lumps about the size of peas. These lumps are dried upon a sand-bath till they are hard, and will bear handling without producing powder. The lumps (quite free from dust) are placed in tubes *not more than an inch in diameter*. When the lime is cold, bisulphide of carbon is poured upon it in sufficient quantity to saturate the lime, and leave a few drops in each tube. The tubes are corked, and allowed to stand for three or four days. Water is then poured in carefully, so as not to remove any powder from the lumps of lime, and the tubes are closed and allowed to stand as long as the crystals increase in size. To obtain the crystals, the mother-liquor is poured off, the mass of lime, &c. is dried at ordinary temperatures, and the crystals are picked out. For success, it is absolutely necessary that the lime should be in lumps, the vessel in which the reaction takes

place of small diameter, and that undecomposed bisulphide of carbon be present.

Crystals so prepared appear to be perfectly permanent ; they do not undergo alteration from several weeks' exposure to atmospheric changes. I have not yet obtained them free from adhering lime, as all acids which will dissolve the lime decompose the crystals. They are soluble in water, but cannot be recrystallized from their solution. All the solutions I have yet tried decomposed without crystallizing. Other processes have equally failed to furnish a salt which can be obtained dry and pure ; and I am therefore unable at present to furnish reliable concurrent analyses which will establish its formula.

I have not ventured an explanation of the reaction, because I am not yet acquainted with the compounds produced and their relative proportion. To ascertain whether an explanation based upon a reaction between the elements of water and bisulphide of carbon was tenable, I caused caustic lime to be heated to whiteness in a platinum crucible for two hours, and cooled out of contact with air. When cold, this anhydrous lime was saturated with dry bisulphide of carbon ; and in a short time the lime became of a greenish-yellow colour, showing the progress of a reaction between the dry lime and the bisulphide of carbon.

Some of the reactions of this salt are remarkable ; and more than one will exhibit the liability to error from the use of any but the most perfectly crystalline, dry, and clean specimens. Baryta-water added in excess throws down from an aqueous solution of the *pure* salt an amorphous, red, insoluble precipitate quite as brilliant in colour as vermilion. If this be washed directly after precipitation, the colour is retained for a considerable period ; but if left in the mother-liquor, it soon darkens. The washed salt dries a brickdust red.

If, instead of the perfectly pure lime-salt, a solution of the salmon-coloured compound, which is formed when the salt is prepared in large vessels and with powdery lime, be taken, a brownish-yellow crystalline double salt of baryta and lime is formed, which is very soluble in water.

Nitrate of baryta gives lemon-yellow crystals in a red-brown mother-liquor with solution of the salmon-coloured mass, but an amorphous dirty grey precipitate in a yellowish mother-liquor with solution of the pure salt.

As soon as a quantity of the latter can be prepared, I hope to isolate the acid.

Salts of the oxides of barium, magnesium, strontium, silver, zinc, manganese, and chromium have been prepared by the direct action of bisulphide of carbon. Some of these differ considerably from the salts prepared by Berzelius by the action of the bisulphide of carbon upon the sulphides of the metals. The process which furnishes the lime-salt well crystallized will be tried with other compounds, and the results submitted to the Society.

A very offensive suffocating gas is evolved during the decomposition of bisulphide of carbon by lime, which is injurious, if not poisonous; and having suffered severely from breathing this and other noxious compounds derived from the same source, I think it right to call attention to it. I have formed a gas of similar properties by passing bisulphide of carbon and hydrogen together through heated lime, and should not be surprised if it prove to be the long-sought simple sulphide of carbon.

Slightly ammoniacal alcohol breathed from a cloth appears to be the best restorative for the severe depression caused by respiring the offensive gases and vapours above named.

XX. "On the Geometrical Isomorphism of Crystals." By the Rev. W. MITCHELL. Communicated by Dr. FRANKLAND. Received June 12, 1862.

In a paper "On the Geometrical Isomorphism of Crystals," published in the Philosophical Transactions for 1857, by H. J. Brooke, F.R.S., it was shown that all the substances crystallizing in the various forms of the pyramidal and rhombohedral systems might be regarded to be as isomorphous as those belonging to the cubical system.

This isomorphism was shown by so taking the arbitrary primitive pyramid of the one system, or the rhomboid of the other, as to bring these forms nearly isomorphous for every substance in the one system or the other. In this way tables were formed showing that the same notation for any form would be not strictly isomorphous, but plesiomorphous for any other form of another substance bearing the same notation.